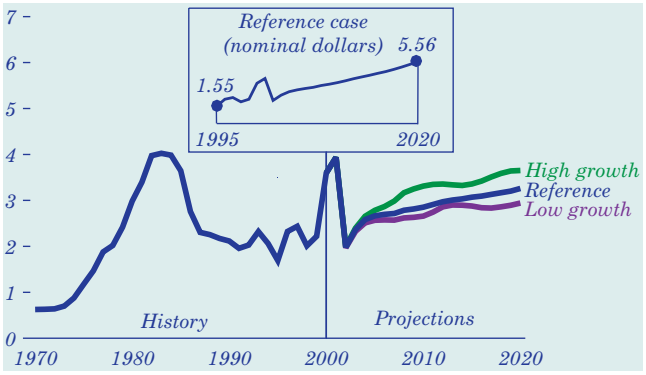
Natural Gas Prices Increase in All Economic Growth Cases

Figure 63. Lower 48 natural gas wellhead prices in three cases, 1970-2020 (2000 dollars per thousand cubic feet)



From 1995 to 2000, the wellhead price of natural gas averaged $2.38 per thousand cubic feet (2000 dollars). Relative to that average, the price is expected to increase at an average rate of 1.6 percent per year in the reference case, reaching $3.26 in 2020 (Figure 63). In the low and high economic growth cases, the wellhead natural gas price is projected to increase at average annual rates of 1.1 percent and 2.2 percent, respectively, to $2.94 per thousand cubic feet in 2020 in the low growth case and $3.65 per thousand cubic feet in the high growth case.

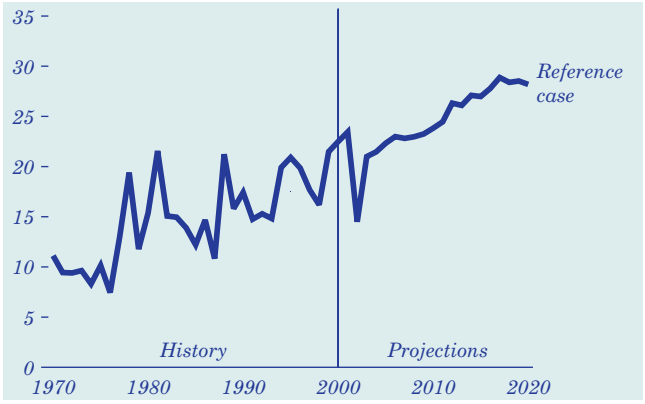
Increasing prices reflect the rising demand for natural gas; the progression of the discovery process from larger, shallower, and more profitable fields to smaller, deeper, and less profitable ones; and increasing production from higher cost sources, such as unconventional natural gas. Projected average growth in production from unconventional sources from 2000 to 2020 ranges from 3.1 to 3.6 percent per year across the cases, compared to a range of 2.0 to 2.2 percent per year for conventional sources. Technically recoverable gas resources (Table 10) are expected to remain more than adequate to meet the projected production increases. The price increases are expected to be tempered by technological progress in both discovering and producing natural gas.

Table 10. Technically recoverable U.S. natural gas resources as of January 1, 2000 (trillion cubic feet)

Proved	*167*
Unproved	*1,023*
Total	***1,190***

High Levels of Gas Reserve Additions Are Projected Through 2020

Figure 64. Lower 48 natural gas reserve additions, 1970-2020 (trillion cubic feet)



For most of the past two decades, production of natural gas in the lower 48 States has exceeded reserve additions. That pattern was reversed, however, for most of the period from 1994 through 2000. Only in 1998 did reserve additions fall below production, because of low prices. After 2002, rising prices are expected to result in natural gas reserve additions that exceed production (Figure 64), even as projected production increases.

The projected levels of natural gas reserve additions through 2020 reflect the expected increase in exploratory and developmental drilling (Table 11) that results from increasing natural gas prices. Reserve additions also reflect the assumed productivity gains from technology improvements, which are comparable with those of recent years.

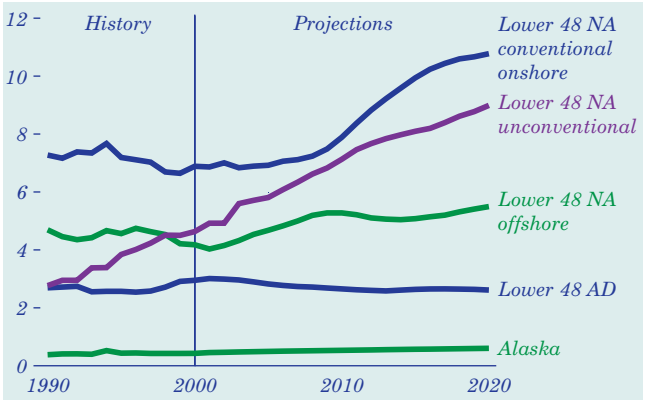
Although reserve additions are expected to fluctuate, they are relatively constant over the last 5 years of the forecast for the three growth cases. In the reference case, reserve additions are expected to average 28.4 trillion cubic feet per year from 2016 through 2020. In the low and high growth cases, projected reserve additions average 27.8 and 29.5 trillion cubic feet per year, respectively.

Table 11. Lower 48 natural gas drilling in three cases, 2000-2020 (thousand successful wells)

	2000	*2010*	*2020*
Low growth case		*14.7*	*19.2*
Reference case	*15.2*	*15.4*	*21.7*
High growth case		*17.2*	*23.9*

Growing Numbers of New Wells Increase Natural Gas Production

Figure 65. Natural gas production by source, 1990-2020 (trillion cubic feet)



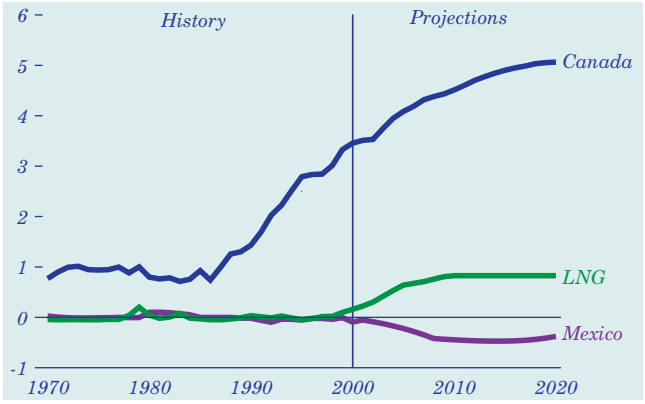
Growth in domestic natural gas production is expected to come primarily from lower 48 onshore nonassociated (NA) sources (Figure 65). Conventional onshore natural gas production is projected to grow rapidly in the last 10 years of the forecast, increasing its share of total lower 48 production from 37 percent in 2000 to 39 percent in 2020. As a result of technological improvements, production from unconventional sources (tight sands, shale, and coalbed methane) is projected to increase more rapidly. Unconventional natural gas production is projected to increase from 25 percent of total lower 48 production in 2000 to 32 percent in 2020. Production of associated-dissolved (AD) natural gas from lower 48 crude oil reserves declines slightly in the projections, following the expected pattern of crude oil production. AD natural gas is projected to account for 9 percent of lower 48 natural gas production in 2020, compared with 16 percent in 2000.

Offshore production is expected to increase less rapidly, accounting for 24 percent of total lower 48 gas production in 2020. In recent years, innovative cost-saving technologies have been applied, particularly in the deep waters of the Gulf of Mexico, where significant finds are expected to continue.

Alaskan natural gas production is projected to grow by 1.7 percent per year through 2020 to meet expected State demand. Options for marketing the gas outside Alaska include transportation through a pipeline, conversion to liquefied natural gas (LNG), and conversion to synthetic petroleum products (which accounts for 0.9 trillion cubic feet of natural gas consumption in 2020 in the high oil price case).

Net Imports of Natural Gas Grow in the Projections

Figure 66. Net U.S. imports of natural gas, 1970-2020 (trillion cubic feet)



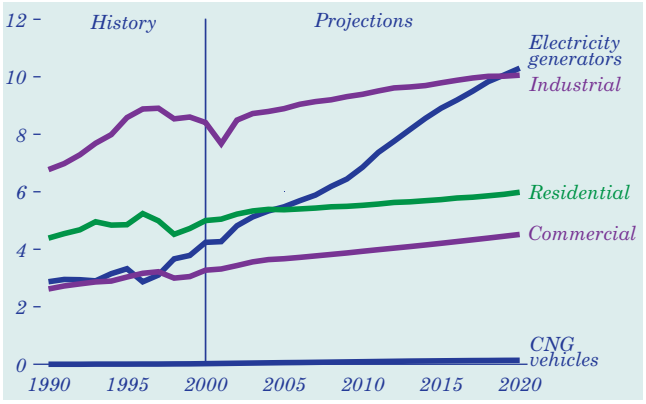
Net imports of natural gas make up the difference between U.S. production and consumption (Figure 66). Imports are generally expected to be priced competitively with domestic sources. Imports from Canada, primarily from western Canada and the Scotian Shelf in the offshore Atlantic, are expected to make up most of the increase in U.S. imports. Because most of the producing regions in Canada are less mature than those in the United States, there is strong potential for low-cost production. Net imports from Canada are projected to provide 15 percent of total U.S. supply in 2020, about the same as in 2000.

LNG imports are expected to increase, but they are not expected to become a major source of U.S. supply through 2020. Two LNG import facilities, at Cove Point, Maryland, and Elba Island, Georgia, have been closed for many years but are expected to reopen by 2002. It is expected that those facilities, plus the other two U.S. facilities, at Everett, Massachusetts, and Lake Charles, Louisiana, will be operating at full capacity by 2010, supplying 0.8 trillion cubic feet per year through 2020.

Although Mexico has a considerable natural gas resource base, trade with Mexico has until recently consisted primarily of exports from the United States. Mexico is projected to remain a net importer of U.S. natural gas through 2020; however, U.S. exports are expected to peak in 2015 and then decline as the infrastructure is developed for Mexican natural gas to meet indigenous demand.

Projected Increases in Natural Gas Use Are Led by Electricity Generators

Figure 67. Natural gas consumption by sector, 1990-2020 (trillion cubic feet)

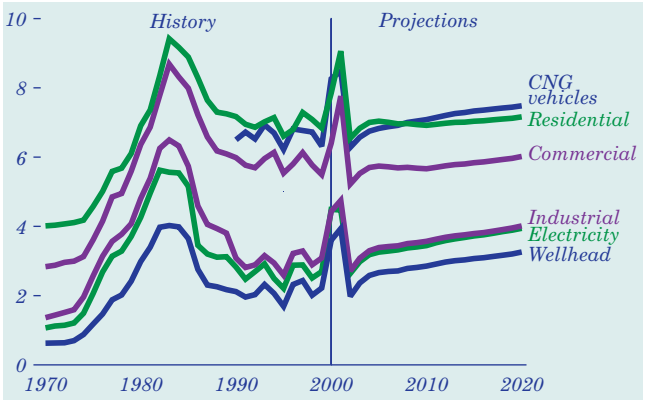


Total natural gas consumption is projected to increase from 2000 to 2020 in all the *AEO2002* cases. The projections for domestic consumption in 2020 range from 32.0 trillion cubic feet per year in the low economic growth case to 35.0 trillion cubic feet per year in the high economic growth case, as compared with an estimated 22.8 trillion cubic feet in 2000. In the reference case, increasing demand by electricity generators (excluding cogenerators) is expected to account for 55 percent of the total consumption growth by 2020 (Figure 67). Demand growth is also expected in the residential, commercial, industrial, and transportation sectors. Most new electricity generation capacity is expected to be fueled by natural gas, and natural gas consumption in the electricity sector is projected to grow rapidly throughout the forecast as electricity consumption increases.

In the reference case, natural gas consumption for electricity generation (excluding cogeneration) is projected to increase from 4.2 trillion cubic feet per year in 2000 to 10.3 trillion cubic feet per year in 2020, an average annual growth rate of 4.5 percent. At the end of the forecast period, electricity generation is expected to surpass the industrial sector as the largest consumer of natural gas. Although coal prices to the electricity generation sector are generally projected to fall throughout the forecast, natural-gas-fired electricity generators are expected to have advantages over coal-fired generators, including lower capital costs, higher fuel efficiency, shorter construction lead times, and lower emissions.

Delivered Prices Increase More Slowly Than Wellhead Prices

Figure 68. Natural gas end-use prices by sector, 1970-2020 (2000 dollars per thousand cubic feet)



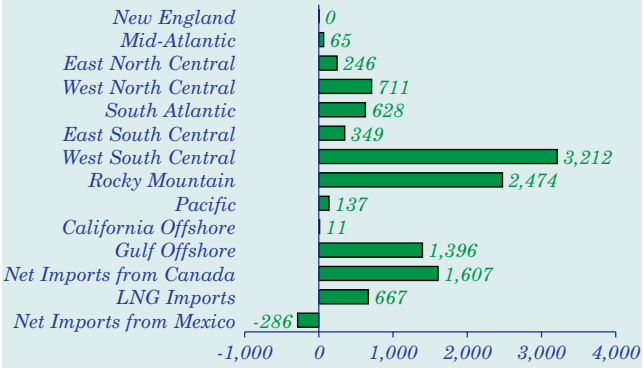
Long-term end-use prices for natural gas are projected to be lower than the relatively high prices experienced in 2000 and 2001. Average transmission and distribution margins are generally expected to remain constant or decline through 2020, moderating the projected increase in wellhead prices. The average end-use price is expected to increase by 35 cents per thousand cubic feet from 2005 through 2020, compared with an increase of 61 cents per thousand cubic feet in the average price of domestic and imported supply in the same period.

Declining margins are particularly important in restraining the rise in both residential and commercial end-use prices (Figure 68). From 2005 through 2020, residential and commercial end-use prices are projected to increase by only 12 cents per thousand cubic feet and 28 cents per thousand cubic feet, respectively.

The industrial and electricity generation sectors have the lowest end-use prices, in part because they receive most of their natural gas directly from interstate pipelines, avoiding local distribution charges. Summer-peaking electricity generators reduce their transmission costs by using lower cost interruptible transportation rates during the summer when spare pipeline capacity is available; however, as electricity generators take an increasing share of the market, they are expected to rely on higher cost firm transportation to a greater extent. The highest end-use prices are expected for compressed natural gas vehicles, because the costs of additional infrastructure requirements are expected to be added to pipeline and distribution rates.

Natural Gas Supplies from the West Are Expected To Grow

Figure 69. Projected changes in lower 48 natural gas supply by region and source, 2000-2020 (billion cubic feet)



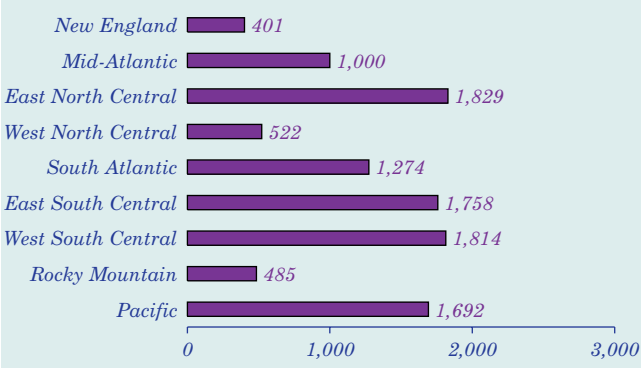
In the reference case, total lower 48 natural gas supplies are projected to grow by 11.2 trillion cubic feet between 2000 to 2020. Lower 48 natural gas production is expected to increase by 9.2 trillion cubic feet, accounting for 82 percent of the total growth in supply, and net imports are projected to increase by 2.0 trillion cubic feet, accounting for the remaining 18 percent.

The traditional onshore natural gas production areas of Louisiana, Oklahoma, and Texas are projected to have the largest growth in lower 48 production between 2000 and 2020, 3.2 trillion cubic feet (Figure 69). The next largest increase in lower 48 natural gas production, 2.5 trillion cubic feet, is projected to come from the Rocky Mountain region, predominantly from unconventional sources. Offshore Gulf of Mexico is expected to account for 1.4 trillion cubic feet of incremental lower 48 supply. Natural gas production from the West North Central region, primarily Kansas, is projected to grow by about 0.7 trillion cubic feet. In the South Atlantic region, Appalachian production is expected to grow by 0.6 trillion cubic feet per year.

Net imports of Canadian natural gas and LNG are expected to provide 1.6 trillion cubic feet and 0.7 trillion cubic feet, respectively, of incremental lower 48 natural gas supplies through 2020. About two-thirds of the growth in LNG imports, 440 billion cubic feet, is expected to be in the South Atlantic region as a result of the reactivation of the Cove Point, Maryland, and Elba Island, Georgia, terminals.

Natural Gas Consumption Is Expected To Increase in All Regions

Figure 70. Projected changes in lower 48 natural gas consumption by region, 2000-2020 (billion cubic feet)

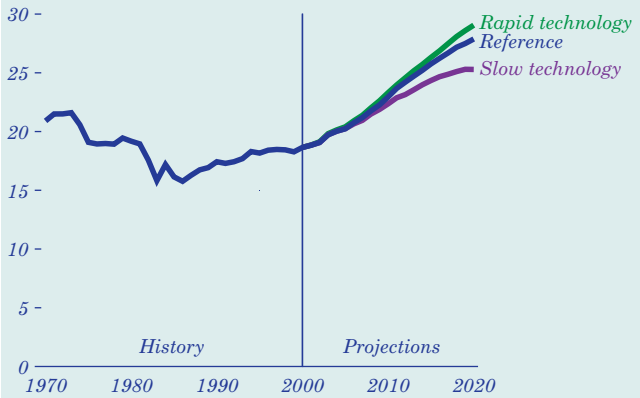


In the reference case, 58 percent of the growth in lower 48 natural gas consumption between 2000 to 2020 is projected to occur East of the Mississippi River, with the remaining 42 percent West of the Mississippi River (Figure 70). In the East, the largest increases in natural gas consumption are expected in the East North Central and East South Central regions, with each region accounting for 1.8 trillion cubic feet of incremental consumption. In the West, natural gas demand in the Pacific and West South Central regions is expected to increase by 1.7 trillion cubic feet and 1.8 trillion cubic feet, respectively. Together, these four regions are projected to account for 66 percent of the total increase in natural gas demand between 2000 to 2020 in the reference case.

Although more than half the increase in natural gas consumption between 2000 to 2020 is expected in the East, the West—including Canadian imports and most of the Gulf Offshore—is expected to provide approximately 80 percent of the incremental lower 48 natural gas supply in the reference case. As a result, most new natural gas pipelines are expected to be built from the West to the East. The exception is expected new pipeline capacity originating in Canada and the Rocky Mountains, which will be needed to meet growth in natural gas consumption along the Pacific Coast.

Technology Advances Could Improve Finding and Drilling Success Rates

Figure 71. Lower 48 natural gas production in three cases, 1970-2020 (trillion cubic feet)



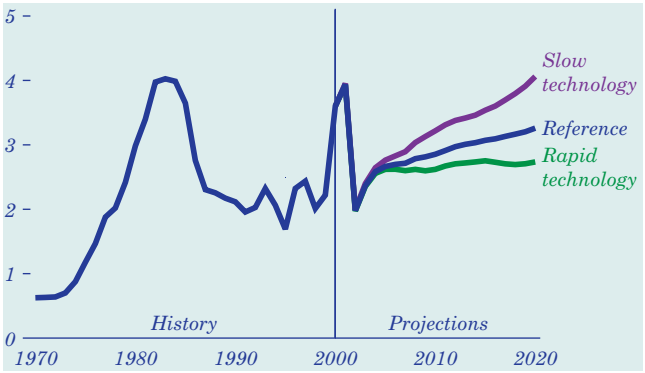
Continued improvements in technology have the potential to result in lower production costs for natural gas from the same resource base. The *AEO2002* reference case assumes that improvements in technology will continue at historic rates. The slow and rapid technology cases assume that the annual rate of technological improvement in production costs, finding rates, and success rates will respectively decrease or increase by 25 percent, relative to the historical rate.

The rapid technology case projects lower wellhead prices for natural gas, higher production, and higher consumption compared to the reference case. The slow technology case has the opposite effect of raising projected prices and lowering both production and consumption. In 2020, total U.S. natural gas production is expected to be 4 percent higher in the rapid technology case and 9 percent lower in the slow technology case than in the reference case (Figure 71). The strongest impacts are for production from unconventional natural gas sources, which are expected to be 15 percent higher in the rapid technology case and 17 percent lower in the slow technology case than in the reference case.

The impacts of the rapid and slow technology assumptions are more significant for natural gas production than for consumption. In 2020, natural gas consumption in the slow technology case is expected to be 8 percent lower than in the reference case.

Natural Gas Price Projections Change With Technology Assumptions

Figure 72. Lower 48 natural gas wellhead prices in three cases, 1970-2020 (2000 dollars per thousand cubic feet)

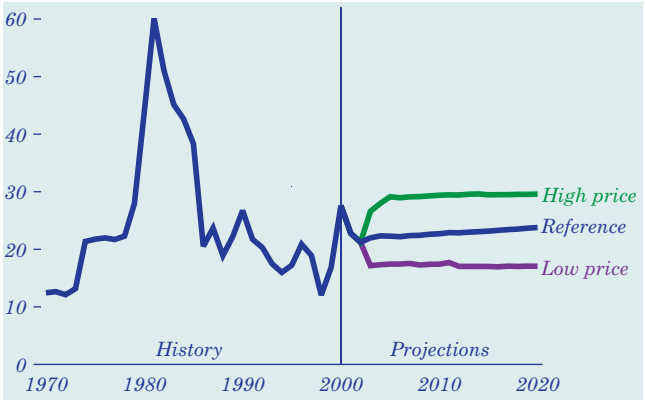


Wellhead natural gas prices are expected to be more sensitive to variation in technological change than are the levels of natural gas production and consumption (Figure 72). The projected price of natural gas supplies reflects the long-run marginal cost of domestic natural gas production and imports, which depends strongly on technological progress. Natural gas production and imports, however, vary across the technology cases only to the extent that demand for natural gas responds to the change in price. Natural gas demand is relatively unresponsive to price changes in the short term but can be more responsive over time as price differences among competing fuels lead to different decisions with regard to purchases of natural-gas-consuming equipment.

Over the projection period, lower 48 natural gas wellhead prices are projected to increase at average annual rates of 1.6 percent per year in the reference case, 2.7 percent in the slow technology case, and 0.7 percent in the rapid technology case, as compared with the average wellhead natural gas price of $2.38 per thousand cubic feet between 1995 and 2000. The slow technology case projects a wellhead price of $4.06 per thousand cubic feet in 2020, which is 25 percent higher than the reference case price of $3.26 per thousand cubic feet in 2020. In the rapid technology case, lower 48 natural gas wellhead prices are projected to remain relatively flat from 2005 through 2020, reaching $2.73 per thousand cubic feet in 2020, which is 16 percent lower than in the reference case.

Oil Prices Are Expected To Remain Above Low 1998 Levels

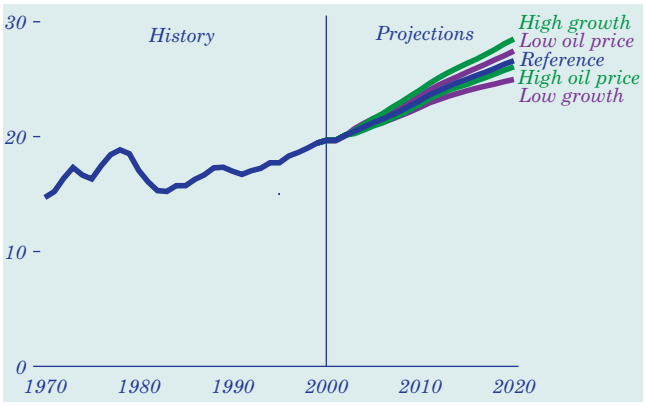
Figure 73. Lower 48 crude oil wellhead prices in three cases, 1970-2020 (2000 dollars per barrel)



Crude oil prices are determined largely by the international market and production in OPEC and non-OPEC nations. In the reference case, the average lower 48 crude oil price is projected to increase on average by 0.6 percent per year after 2002, to $23.79 per barrel in 2020. The high and low world oil price cases use different assumptions for OPEC production. In the high price case, the lower 48 crude oil price increases by 1.9 percent per year from 2002 to 2020, when it is $29.58 per barrel, or 24 percent higher than in the reference case (Figure 73). In the low price case, the lower 48 price generally declines through 2015, to $17.06 per barrel in 2020.

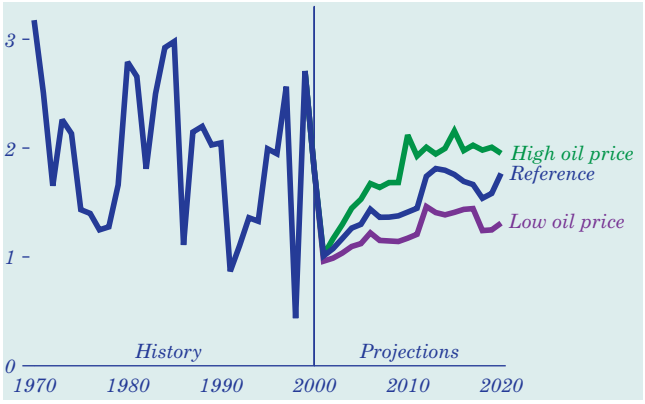
Projected U.S. petroleum consumption varies with crude oil price assumptions, but the largest variation is seen for different assumptions about economic growth. Total consumption in 2020 ranges from 25.0 million barrels per day to 28.5 million in the low and high growth cases, respectively (Figure 74).

Figure 74. U.S. petroleum consumption in five cases, 1970-2020 (million barrels per day)



Projected Oil Reserve Additions Are Sensitive to Oil Price Assumptions

Figure 75. Lower 48 crude oil reserve additions in three cases, 1970-2020 (billion barrels)



Crude oil reserve additions are sensitive to crude oil price projections (Figure 75). In the projections for 2020, lower 48 crude oil reserve additions range from a low of 1.3 billion barrels in the low world oil price case to 2.0 billion barrels in the high world oil price case. Reserve additions associated with enhanced oil recovery techniques are the category most sensitive to variations in projected world oil prices, with lower 48 additions ranging from 142 million barrels in the low oil price case to 423 million barrels in the high oil price case. Crude oil reserve additions reflect the level of oil wells completed during the forecast period (Table 12) and the size of the crude oil resource base (Table 13).

Table 12. Crude oil drilling in three cases, 2000-2020 (thousand successful wells)

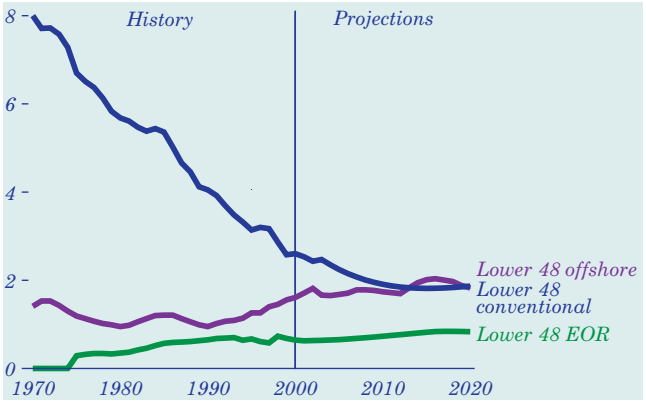
	2000	2010	2020
Low oil price case		*4.1*	*4.2*
Reference case	*4.7*	*4.4*	*4.5*
High oil price case		*4.9*	*4.8*

Table 13. Technically recoverable U.S. oil resources as of January 1, 2000 (billion barrels)

Proved	*23*
Unproved	*113*
Total	***136***

Lower 48 Crude Oil Production Continues To Decline

Figure 76. Lower 48 crude oil production by source, 1970-2020 (million barrels per day)



In the reference case, total lower 48 crude oil production is projected to decline from 2000 to 2012, increase from 2012 to 2016, and then decline again. By 2020, total lower 48 production is expected to be 4.5 million barrels per day, as compared with 4.9 million barrels per day in 2000. In the high oil price case, reserve additions are expected to be sufficient to support increases in lower 48 production over the projection period, reaching 5.3 million barrels per day in 2020. In the low price case, lower 48 crude oil production is projected to decline through 2020 to 3.9 million barrels per day. Production from enhanced oil recovery, which was 0.7 million barrels per day in 2000, is projected to reach 0.8 million barrels per day in the reference case (Figure 76), 0.5 million in the low price case, and 1.2 million in the high price case in 2020 [*89*].

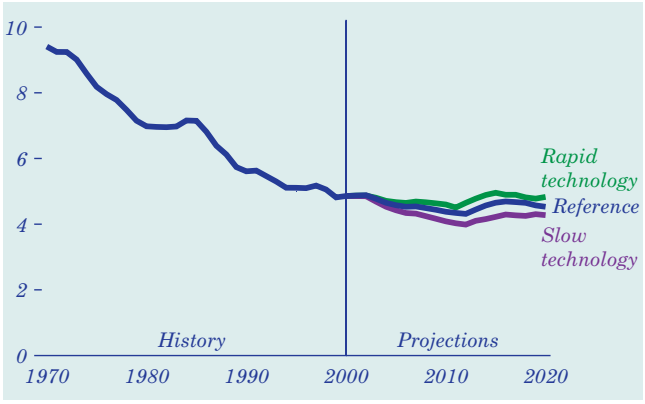
Total offshore production of crude oil was 1.6 million barrels per day in 2000 and is projected to increase to 1.8 million in 2020 in the reference case, 1.6 million in the low price case, and 2.1 million in the high price case. The offshore Gulf of Mexico region is an important production region, and its deepwater development is a major frontier area. Production from the Gulf is expected to increase slightly by 2020 (Table 14). Offshore crude oil reserves are projected to increase as a share of lower 48 oil reserves, from 23 percent in 2000 to 27 percent in 2020.

Table 14. Crude oil production from Gulf of Mexico offshore, 2000-2020 (million barrels per day)

	2000	2010	2020
Shallow	*0.7*	*0.7*	*0.4*
Deep	*0.8*	*0.9*	*1.2*
Total	***1.5***	***1.6***	***1.6***

More Rapid Technology Advances Could Raise Oil Production Slightly

Figure 77. Lower 48 crude oil production in three cases, 1970-2020 (million barrels per day)



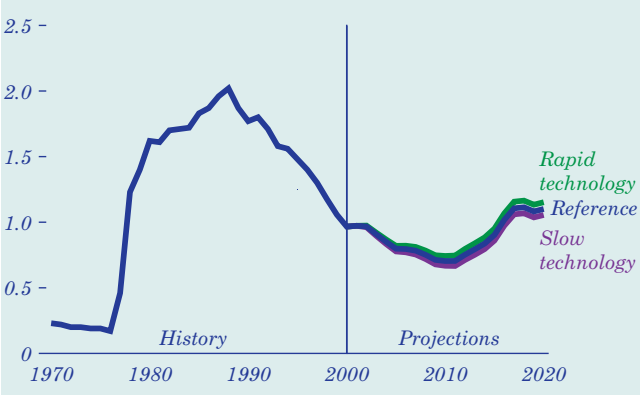
Lower 48 crude oil production is projected to reach 4.8 and 4.3 million barrels per day in 2020 in the rapid and slow technology cases, respectively, compared to 4.5 million barrels per day in the reference case (Figure 77). The technology cases assume the same world oil prices as in the reference case. Because oil prices are determined by world markets and domestic consumption is not expected to change significantly in the technology cases, changes in production result in different levels of petroleum imports. In 2020, net petroleum imports are projected to range from 16.0 million barrels per day in the rapid technology case to 17.7 million barrels per day in the slow technology case.

Offshore crude oil production in the lower 48 States is expected to be more sensitive to the assumed changes in technological progress than onshore production, because large deepwater fields that are not profitable in the slow technology case are expected to become profitable in the rapid technology case. Relative to the reference case, cumulative offshore production from 2000 through 2020 is projected to be 555 million barrels (4 percent) higher in the rapid technology case and 750 million barrels (5 percent) lower in the slow technology case.

Projected lower 48 onshore crude oil production shows a larger variation in volume than does offshore production. Relative to the reference case, cumulative onshore production from 2000 through 2020 is projected to be 753 million barrels (4 percent) higher in the rapid technology case and 1,140 million barrels (5 percent) lower in the slow technology case.

Crude Oil Production in Alaska Is Projected To Rebound

Figure 78. Alaskan crude oil production in three cases, 1970-2020 (million barrels per day)



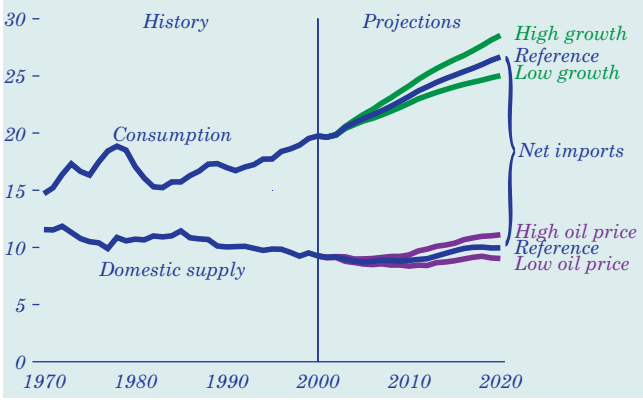
Alaskan crude oil production is expected mainly on the Alaskan North Slope, including the National Petroleum Reserve-Alaska (NPR-A), the State lands surrounding Prudhoe Bay. The first NPR-A lease sale was held on May 5, 1999. Because drilling is currently prohibited in the Arctic National Wildlife Refuge (ANWR), *AEO2002* does not project any production from ANWR.

Crude oil production from Alaska is expected to decline to 0.7 million barrels per day in 2010 in the reference case (Figure 78). Projected drops in production from most Alaskan fields, particularly Prudhoe Bay, the State's largest producing field, are expected to be offset by production from the NPR-A, beginning in 2010. This date is based on the expectation that a decade will be required to explore and develop new oil fields and to build the associated infrastructure. After 2010, total Alaskan crude oil production is projected to grow to 1.1 million barrels per day by 2020, 14 percent higher than the 2000 production level. In the reference case, Alaskan crude oil production is projected to decline from 17 percent of total U.S. production in 2000 to 14 percent in 2010 and then to increase to a 20-percent share by 2020.

Alaska's oil production is expected to show similar sensitivity to changes in assumed technological progress as lower 48 oil production. Relative to the reference case, cumulative Alaskan production from 2000 through 2020 is projected to be 254 million barrels (4 percent) higher in the rapid technology case and 235 million barrels (4 percent) lower in the slow technology case.

Imports Fill the Gap Between Domestic Supply and Demand

Figure 79. Petroleum supply, consumption, and imports, 1970-2020 (million barrels per day)



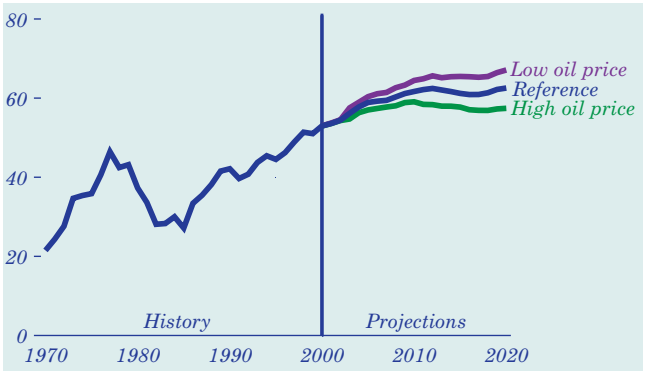
In the reference case, domestic petroleum supply is projected to increase from its 2000 level of 9.3 million barrels per day to 10.0 million barrels per day in 2020 (Figure 79). As U.S. crude oil production falls off, refinery gain and production of natural gas plant liquids are projected to increase. Domestic supply in 2020 is projected to fall to 9.0 million barrels per day in the low oil price case and to rise to 11.1 million barrels per day in the high oil price case.

The greatest variation in petroleum consumption levels is seen across the economic growth cases, with a projected increase of 8.8 million barrels per day over the 2000 level in the high growth case, compared with a projected increase of only 5.3 million barrels per day in the low growth case.

Additional petroleum imports would be needed to fill the projected widening gap between supply and consumption. The greatest gap between supply and consumption is projected in the low oil price case and the smallest in the high oil price case. The projections for net petroleum imports in 2020 range from a high of 18.4 million barrels per day in the low oil price case to a low of 15.0 million barrels per day in the high oil price case, compared with 16.6 million barrels per day in the reference case, increasing from 10.4 million barrels per day in 2000. The expected value of petroleum imports in 2020 ranges from $130.0 billion in the low world oil price case to $185.8 billion in the high economic growth case. Total annual U.S. expenditures for petroleum imports, which reached a historical peak of $139.5 billion (in 2000 dollars) in 1980 [*90*], were $106.5 billion in 2000.

Growing Dependence on Petroleum Imports Is Projected

Figure 80. Share of U.S. petroleum consumption supplied by net imports in three cases, 1970-2020 (percent)



In 2000, net imports of petroleum accounted for 53 percent of domestic petroleum consumption. Continued dependence on petroleum imports is projected, reaching 62 percent in 2020 in the reference case (Figure 80). The corresponding import shares of total consumption in 2020 are expected to be 57 percent in the high oil price case and 67 percent in the low oil price case.

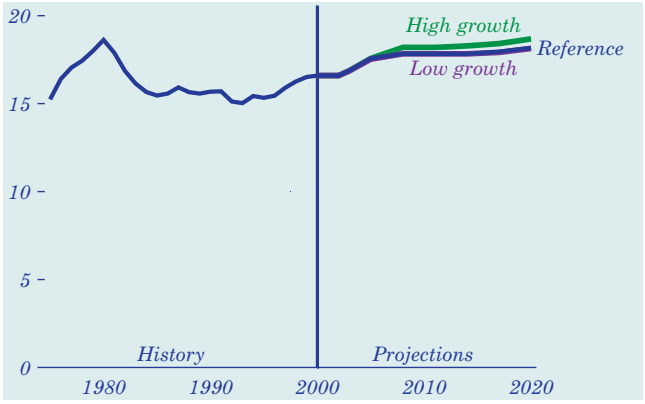
Although crude oil is expected to continue as the major component of petroleum imports, refined products are projected to represent a growing share. More imports would be needed as the projected growth in demand for refined products exceeds the expansion of domestic refining capacity. Refined products are projected to make up 26 percent of net petroleum imports in 2020 in the low economic growth case and 38 percent in the high growth case, compared with 33 percent in the reference case, increasing from a 13-percent share in 2000 (Table 15).

Table 15. Petroleum consumption and net imports in five cases, 2000 and 2020 (million barrels per day)

Year and projection	Product supplied	Net imports	Net crude imports	Net product imports
2000	19.7	10.4	9.0	1.4
2020				
Reference	26.7	16.6	11.2	5.4
Low oil price	27.5	18.5	12.4	6.1
High oil price	26.1	15.0	10.1	4.9
Low growth	25.0	15.3	11.3	4.0
High growth	28.5	18.4	11.5	6.9

New U.S. Oil Refining Capacity Is Likely To Be at Existing Refineries

Figure 81. Domestic refining capacity in three cases, 1975-2020 (million barrels per day)



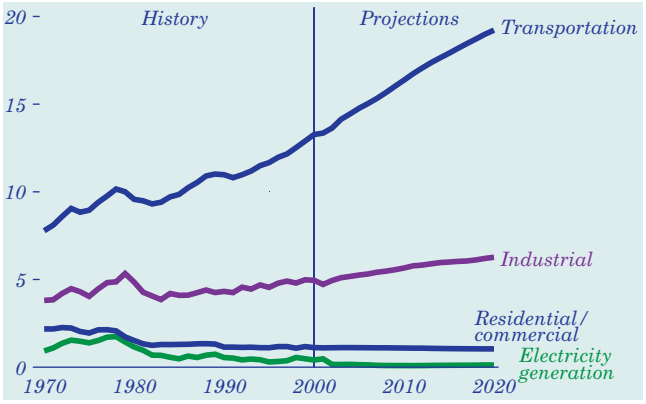
Falling demand for petroleum and deregulation of the domestic refining industry in the 1980s led to 13 years of decline in U.S. refinery capacity. That trend was reversed in 1995, with 1.6 million barrels per day of distillation capacity added by 2001. Financial and legal considerations make it unlikely that new refineries will be built in the United States, but additions at existing refineries are expected to increase total U.S. refining capacity in all the *AEO2002* cases (Figure 81).

Distillation capacity is projected to grow from the 2000 year-end level of 16.6 million barrels per day to 18.2 million barrels per day in 2020 in the reference case, 18.1 million in the low economic growth case, and 18.7 million in the high growth case, compared with the 1981 peak of 18.6 million barrels per day. Almost all the capacity additions are projected to occur on the Gulf Coast. Existing refineries are expected to continue to be utilized intensively throughout the forecast, in a range of 90 to 94 percent of design capacity. The 2000 utilization rate was 93 percent, well above the rates of 69 to 88 percent in the 1980s and early 1990s.

Additional "downstream" processing units are expected to allow domestic refineries to produce less residual fuel, which has a shrinking market, and more of the higher value "light products," such as gasoline, distillate, jet fuel, and liquefied petroleum gas.

Petroleum Use Increases Mainly in the Transportation Sector

Figure 82. Petroleum consumption by sector, 1970-2020 (million barrels per day)

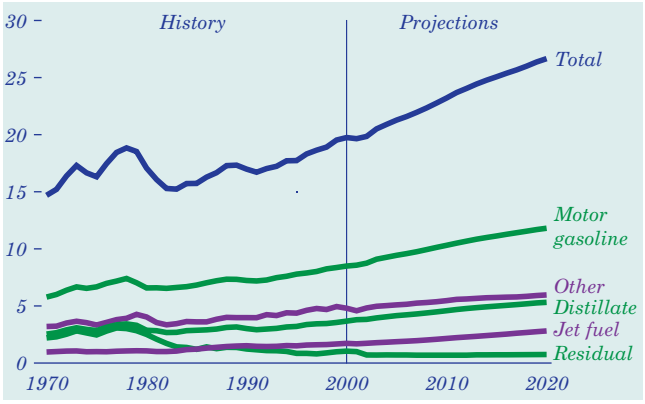


U.S. petroleum consumption is projected to increase by 6.9 million barrels per day between 2000 and 2020. Most of the increase is in the transportation sector (Figure 82), which accounted for two-thirds of U.S. petroleum use in 2000. Petroleum use for transportation increases by 6.0 million barrels per day in the reference case, 4.9 million in the low economic growth case, and 7.1 million in the high economic growth case. In the industrial sector, which currently accounts for 25 percent of U.S. petroleum use, consumption in 2020 is projected to be higher than in 2000 by 1.3 million barrels per day in the reference case, 0.8 million in the low economic growth case, and 2.0 million in the high economic growth case. About 95 percent of the growth is expected in the petrochemical, construction, and refining sectors.

In the reference case, petroleum use for heating and for electricity generation is expected to decline as oil loses market share to natural gas for both uses and to electricity for heating. Increased oil use for heating and electricity generation is projected, however, in the low oil price case. Natural gas use for home heating is growing in New England, the last stronghold of home heating oil. Compared with 2000, total U.S. heating oil use is projected to be 71,000 barrels per day lower in 2020 in the high price case and 42,000 barrels per day higher in the low price case. For electricity generation, oil-fired steam plants are being retired in favor of natural gas combined-cycle units. Oil use for electricity generation (excluding cogeneration) is projected to be 340,000 barrels per day lower in 2020 than in 2000 in the high price case and 160,000 barrels per day higher in the low price case.

Light Products Account for Most of the Increase in Demand for Petroleum

Figure 83. Consumption of petroleum products, 1970-2020 (million barrels per day)

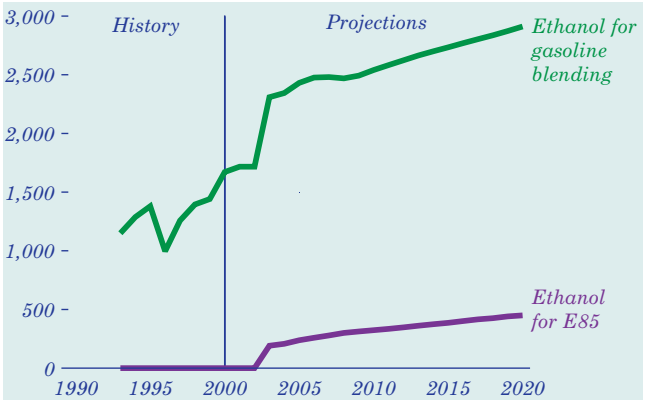


About 94 percent of the projected growth in petroleum consumption stems from increased consumption of "light products," including gasoline, diesel, heating oil, jet fuel, and liquefied petroleum gases, which are more difficult and costly to produce than heavy products (Figure 83). Although refinery investments and enhancements are expected to increase the ability of domestic refineries to produce light products, imports of light products are expected to more than triple by 2020.

In the forecast, gasoline continues to account for almost 45 percent of all the petroleum used in the United States. Between 2000 and 2020, U.S. gasoline consumption is projected to rise from 8.5 million barrels per day to 11.8 million barrels per day. Consumption of distillate fuel is projected to be 1.7 million barrels per day higher in 2020 than it was in 2000, with diesel fuel accounting for 94 percent of the projected increase as demand for freight transportation grows. With air travel also expected to increase, jet fuel consumption is projected to be 1.1 million barrels per day higher in 2020 than in 2000. Consumption of liquefied petroleum gas (LPG), included in "other" petroleum, is projected to increase by about 482,000 barrels per day between 2000 and 2020. Consumption of "other" petroleum products—including petrochemical feedstocks, still gas used to fuel refineries, asphalt and road oil, and other miscellaneous products—is projected to grow by 1.2 million barrels per day. Residual fuel use is projected to decline from 1.1 million barrels per day in 2000 to 750,000 barrels per day in 2020. Most of the projected decline is in residual fuel use for electricity generation.

State Bans on MTBE Are Expected To Result in Increased Use of Ethanol

Figure 84. U.S. ethanol consumption, 1993-2020 (million gallons)



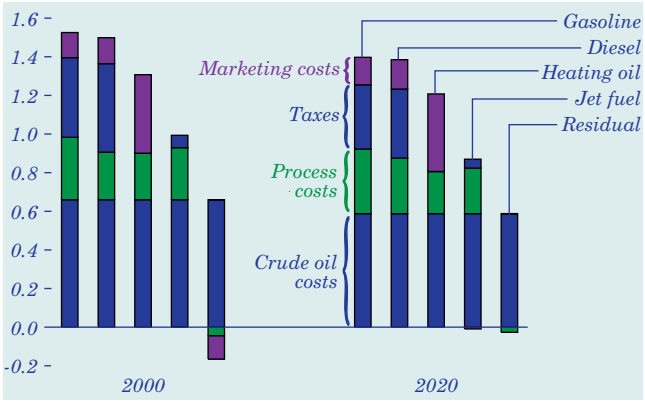
U.S. ethanol production, with corn as the primary feedstock, reached 1.6 billion gallons in 2000. Production is projected to increase to 3.4 billion gallons by 2020 (Figure 84), with more than 40 percent of the growth from the conversion of cellulosic biomass. Ethanol is used primarily in the Midwest as a gasoline volume extender and octane enhancer and also serves as an oxygenate in areas that are required to use oxygenated fuels (minimum 2.7 percent oxygen content by volume) during the winter months to reduce carbon monoxide emissions. The high renewables case projects similar production, but all the projected growth is from cellulose, due to more rapid improvement in the technology. Corn-based ethanol production drops at the end of the forecast, from 80 percent of output in 2015 to 38 percent in 2020.

Ethanol is expected to replace MTBE as the oxygenate for reformulated gasoline (RFG) in 13 States that have placed limits on MTBE use because of concerns about groundwater contamination. It is assumed that the Federal requirement for 2 percent oxygen in RFG will continue in all States. Ethanol consumption in E85 vehicles is also projected to increase, from the national total of 3.3 million gallons in 2000 to 450 million gallons in 2020. E85 vehicles currently are used as government fleet vehicles, flexible-fuel passenger vehicles, and urban transit buses.

The Federal Highway Bill of 1998 extended the excise tax exemption for ethanol through 2007 with reductions from 54 cents per gallon to 53 cents in 2001, 52 cents in 2003, and 51 cents in 2005. It is assumed that the exemption will be extended at 51 cents per gallon (nominal) through 2020.

Refining Costs for Most Petroleum Products Rise in the Forecast

Figure 85. Components of refined product costs, 2000 and 2020 (2000 dollars per gallon)



Refined product prices are determined by crude oil costs, refining process costs (including refiner profits), marketing costs, and taxes (Figure 85). In the *AEO2002* projection, crude oil costs are projected to continue making the greatest contribution to product prices, and marketing costs are projected to remain stable, but the contributions of processing costs and taxes are expected to change considerably.

Refining costs, including processing costs and profits for gasoline and diesel fuel, are expected to increase by 1 to 4 cents per gallon from 2000 to 2020. The increases result primarily from projected growth in demand for gasoline and diesel fuels and the investment needed to meet new Federal requirements for low-sulfur gasoline between 2004 and 2007 and ultra-low-sulfur diesel fuel between 2006 and 2010. Refining costs for heating oil and jet fuel fall by a projected 2 to 4 cents per gallon from 2000 to 2020.

Whereas processing costs tend to increase refined product prices in the forecast, the assumptions made about Federal taxes tend to slow the growth of motor fuel prices. In keeping with the *AEO2002* assumption of current laws and legislation, Federal motor fuel taxes are assumed to remain at nominal 2000 levels throughout the forecast. Although Federal motor fuel have been raised sporadically in the past, the assumption of constant nominal Federal taxes is consistent with history. The net impact of the assumption is an expected decrease in Federal taxes in 2000 dollars between 2000 and 2020—7 cents per gallon for gasoline, 10 cents for diesel fuel, and 1 cent for jet fuel. State motor fuels taxes are assumed to keep up with inflation, as they have in the past.